

Wisconsin DNR Forest Health 2018 Annual Report



**Armillaria mycelial fan in a balsam fir
with canopy loss from desiccation in
April and May 2018.**

Photo by Linda Williams

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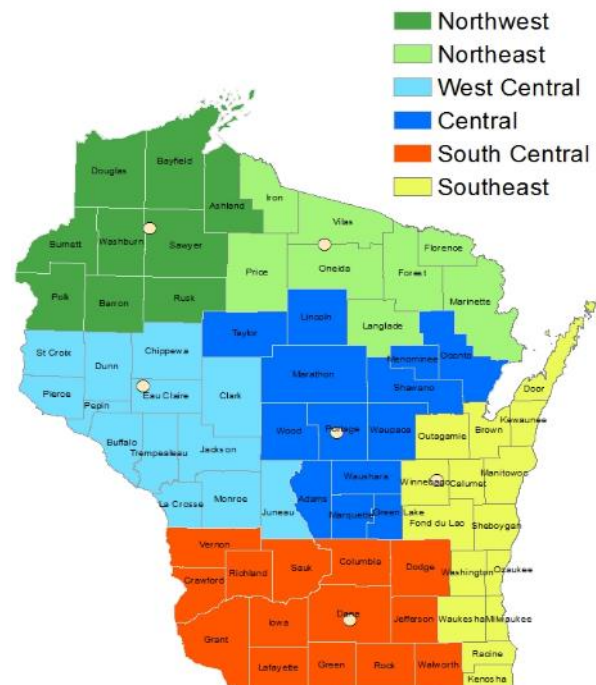


Figure 1. Locations and zones of forest health specialists as of Dec. 2018

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Staff Update

Alex Feltmeyer Alexandra “Alex” Feltmeyer joined the Forest Health Team in October as the forest health specialist for the Central Zone. Her training in urban forestry and master’s work in forest pathology are welcome additions to the breadth of competencies encompassed among the team members.



Mike Putnam Mike has been part of the team as a limited term employee (LTE) for four years preparing an online course on best management practices for forest invasive species and administering two grant programs to control forest invasive plants. This experience will serve him well in his new permanent position as Forest Invasive Plant Coordinator based in Rhinelander.



Mary Bartkowiak We welcome Mary back to the Forest Health Team after two years working with the Department invasive species team focusing on education and enforcement of NR 40, specifically with organisms in trade. Mary has rejoined us as an LTE Invasive Plant Specialist, with an office in Rhinelander. She will be coordinating the Weed Management Area - Private Forest Grant Program and working with DNR staff and partners to detect and control invasive plants.



Marguerite Rapp joined the team as our new education and outreach specialist (LTE) at the end of October following a 9-month fellowship in Baraboo with the Aldo Leopold Foundation. Her master’s work in forest entomology and communications experience make her a great fit for the team. She’s located in Madison at GEF 2, and her work responsibilities include news releases, web content and the Forest Health newsfeed.

Josh Haberstroth joined the forest health team on May 2017 as the summer lab assistant. Future lab assistants will be grateful to him for his clear and well-organized documentation of lab procedures. In May 2018, Josh left us to prepare for a career as a medical doctor and we wish him the best in this endeavor.



Jodie Ellis joined the team in October 2017 as our Education and Outreach specialist. She graced us with her humor and honed communications skills until September 2018 when she moved onto a position at the University of Illinois. We look forward to possible collaboration with Jodie in the future.

Justin Cook joined the team in May 2018 as the summer lab assistant following graduation with a degree in Forest Management from UW-Stevens Point. Justin processed and diagnosed hundreds of samples with a smile over the course of the growing season. The team was happy when he was offered a permanent position as a DNR forester on the Flambeau River State Forest and we look forward to continuing to work with him in his new position.



Strategic Direction of the Forest Health Program

The Forest Health Program provides technical expertise in the prevention, detection, assessment, management and monitoring of invasive plants, insects and diseases that damage trees and forests and the benefits they provide. The program assists public and private landowners in their efforts to minimize the establishment and adverse impacts from invasive plants and destructive forest insects and diseases. Strategic planning for Forest Health has focused efforts on management guidelines, historical data analysis in the annual report and key intra-agency partnerships.

In 2018, the program worked with stakeholder advisory committees to revise “Guidelines for stump treatment to reduce the risk of introduction and spread of *Heterobasidion* root disease in Wisconsin” and “Emerald Ash Borer Silviculture Guidelines”. Revisions were based on recent scientific research, operational logistics, and economic considerations. Both documents have been approved by the advisory committees and Wisconsin chief state forester, Fred Souba, and will be implemented early in 2019.

Reducing the spread of invasive species to Wisconsin DNR managed lands and minimizing their impact once established are high priorities. The Wisconsin State Parks welcome over 14 million visitors a year, and sometimes invasive species hitch a ride. The Forest Health Program partnered with the DNR Bureau of Parks and Recreation on three projects addressing invasive species in 2018. A beech bark disease wildcard was developed to educate visitors to parks in the Door Peninsula and northeastern Wisconsin on the prevention and identification of the insect/disease complex. An oak wilt control pocket was contained, and a timber sale conducted at Nelson Dewey State Park in southwestern Wisconsin to prevent further losses of oak trees in the campground. Emerald ash borer biological controls were released at Peninsula, Kohler-Andrae and Aztalan state parks as part of integrated pest management of the destructive beetle.

The Forest Resource in Wisconsin

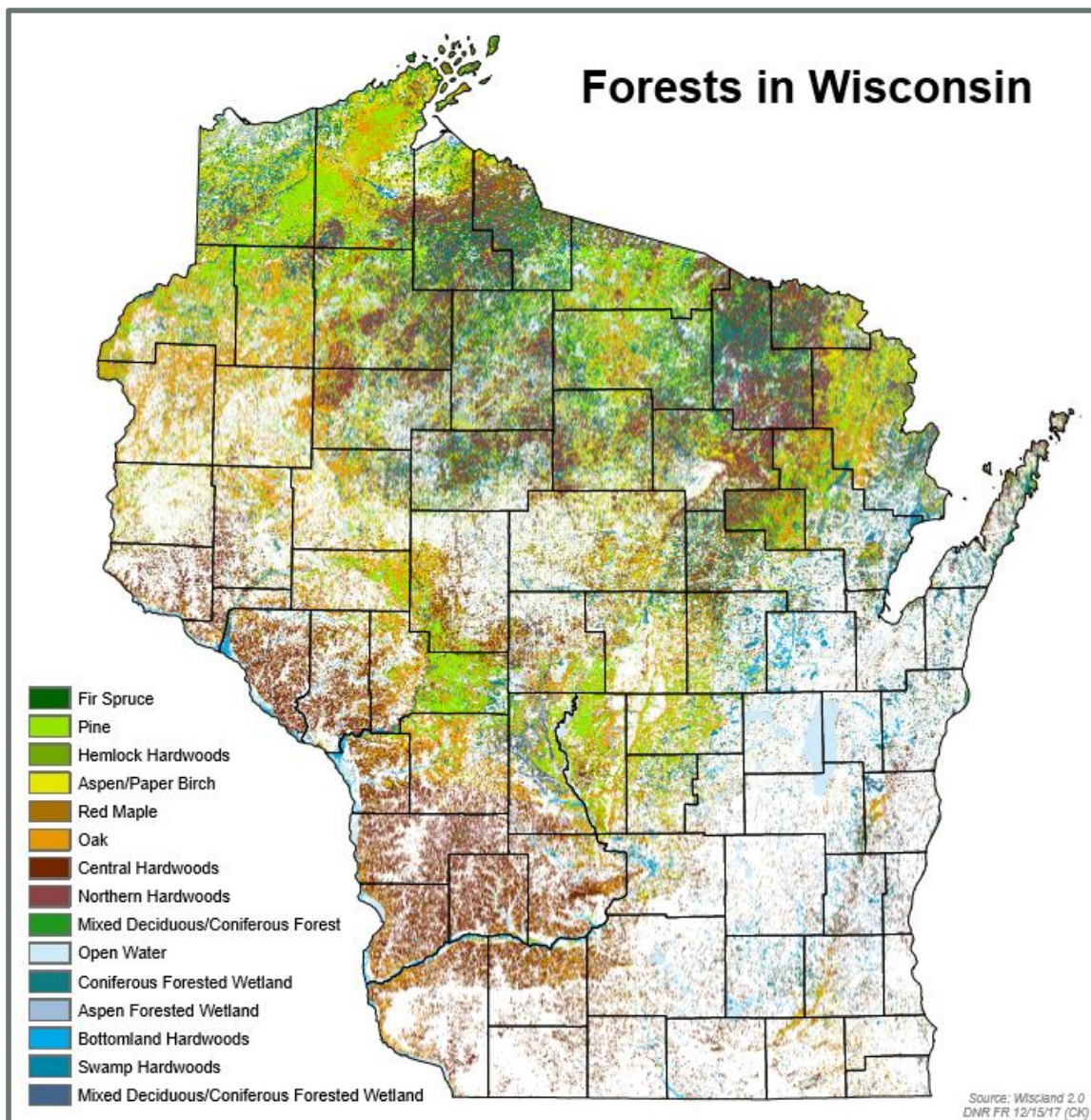


Figure 2. Wisconsin forest cover map. Source: WISCLAND land cover, Wisconsin Dept. of Natural Resources, 2017

Wisconsin's forests are critical for providing wildlife habitat, clean air and water, reducing erosion, and improving the quality of life in urban and rural areas. Forests are also important to the economy of Wisconsin for wood products, recreation and tourism. [Current information on the forest resource in Wisconsin](#) is available at dnr.wi.gov.

The area of forestland in Wisconsin has steadily increased in recent decades and currently stands at approximately 16.5 million acres (Figure 2). This is an increase of 1.8 million acres since 1983 and 845,000 acres since 1996. Wisconsin now has more forested area than at any time since the first forest inventory was conducted in 1936. Over 46% of the state's land area is forested, primarily in the northern and western areas of the state.

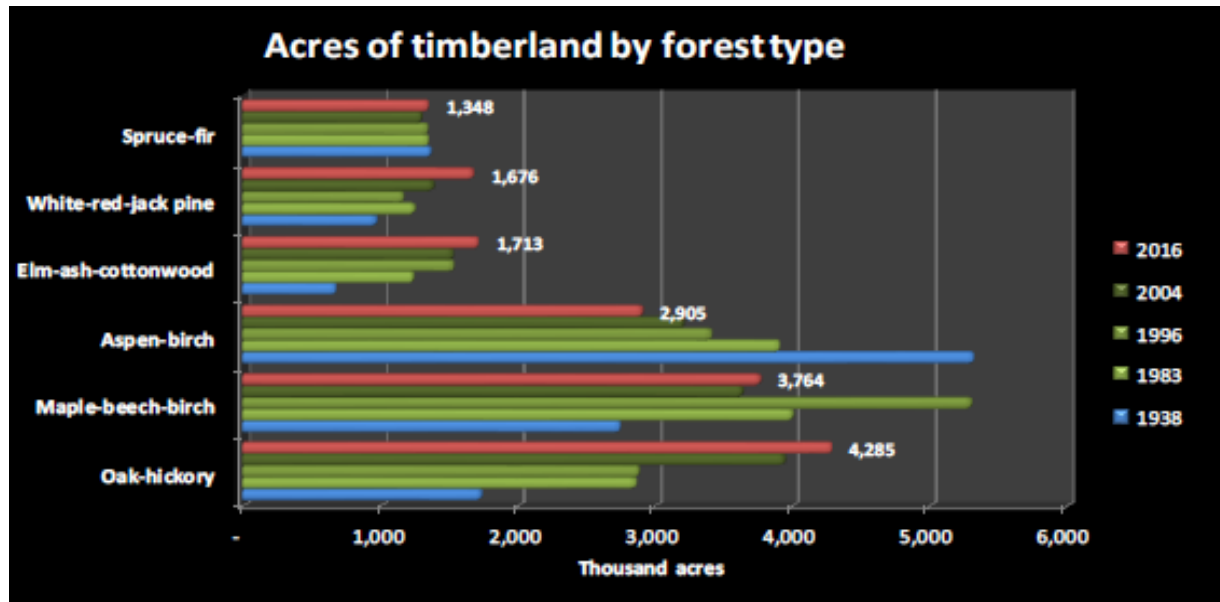


Figure 3. Wisconsin timberland area by forest type (FIA data, US Forest Service)

Wisconsin's forests are composed primarily of hardwood species. The most abundant forest types are oak-hickory at 27% of total forested acreage; maple-beech-birch at 23%; and aspen-birch at 19% (Figure 3). Conifer types, mainly pine and spruce-fir, represent about 19% of the forested area. Wisconsin forests are for the most part mature with the greatest proportion of stands in the 61-80 year class. About two-thirds of Wisconsin's forest lands are privately owned. The remaining third is split between federal, state, local government and tribal ownership.

Exotic Species Issues

Beech bark disease

Beech bark disease is a fatal disease of American beech (*Fagus grandifolia*). It is a disease complex of a scale insect (beech scale, *Cryptococcus fagisuga*) that causes wounds that are subsequently infected by either of two fungi in the genus *Neonectria* (*N. faginata* and *N. ditissima*). Both the scale and *N. faginata* are European in origin but *N. ditissima* is native to North America. In 2009, heavy infestations of beech scales and mortality of beech were detected for the first time in Wisconsin in Door County. In surveys done in 2012-13, beech scale was found to have spread through most of the Wisconsin range of American beech. However, scale populations have remained very low, and no signs of beech bark disease have been observed outside of Door County (Figure. 4).

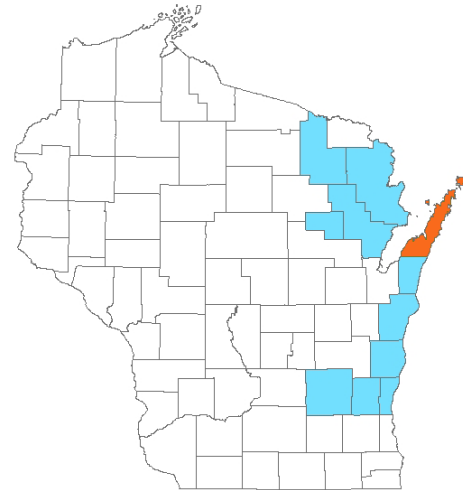


Figure 4. Counties with beech scale detections are shown in blue. Mortality from beech bark disease is limited to Door County in orange.

Approximately 520 acres of scattered beech in eastern Door County were observed to have light, golden-yellow discoloration in the second half of July during aerial survey. This symptom was seen near where tree mortality was recorded and the disease later (*Neonectria ditissima*) confirmed. It is presumed to reflect spread of the disease.

Wisconsin beech entered in breeding program for resistance to beech bark disease

Beech bark disease results from the effects of two components: feeding by non-native scale insects results in wounds then used by the *Neonectria* sp. fungi to enter and kill the beech. From 1 to 5% of American beech trees are resistant to the scale and are therefore not susceptible to beech bark disease. In 2016 and 2017, forest health staff tested three potentially scale-resistant trees as the first step in entering them into a breeding program for beech bark disease resistant American beech. The three candidate trees were located in the beech stand where mortality from the disease complex was first encountered in 2009, at Whitefish Dunes State Park. Despite long exposure to high populations of scales on neighboring beech, these trees appeared free of the pest.

In the summer of 2016, the three candidate trees were administered a treatment wherein scale eggs were placed on pads and sealed onto the bark, forcing interaction of the scales with the tree. In 2017, forest health staff found no life stages of the scale on the three candidate trees, whereas all three control trees contained both adult scales and egg clusters. Having passed initial confirmation of their resistance to scale, scion wood was taken from the three resistant beech trees and sent to the U.S. Forest Service's Northern Research Station in Delaware, Ohio, where they were grafted. Eighteen graftings from the three Wisconsin trees were planted in the Oconto River Seed Orchard in the spring of 2018 and most survived through October. The

Jumping worms (*Amyntas* spp.)

In the summer of 2018 the University of Wisconsin Arboretum began research funded by DNR Forest Health on control options for jumping worms. Treatments tested were Early Bird fertilizer, biochar and diatomaceous earth. Early Bird is an organic, low nitrogen fertilizer used on golf course greens that acts as a vermicide. Preliminary data compiled by Brad Herrick and Marie Johnston indicate moderate mortality rates in adult jumping worms with the use of Early Bird fertilizer but no measurable effect from biochar or diatomaceous earth. The next step is to determine appropriate application rates for control of *Amyntas* worms.

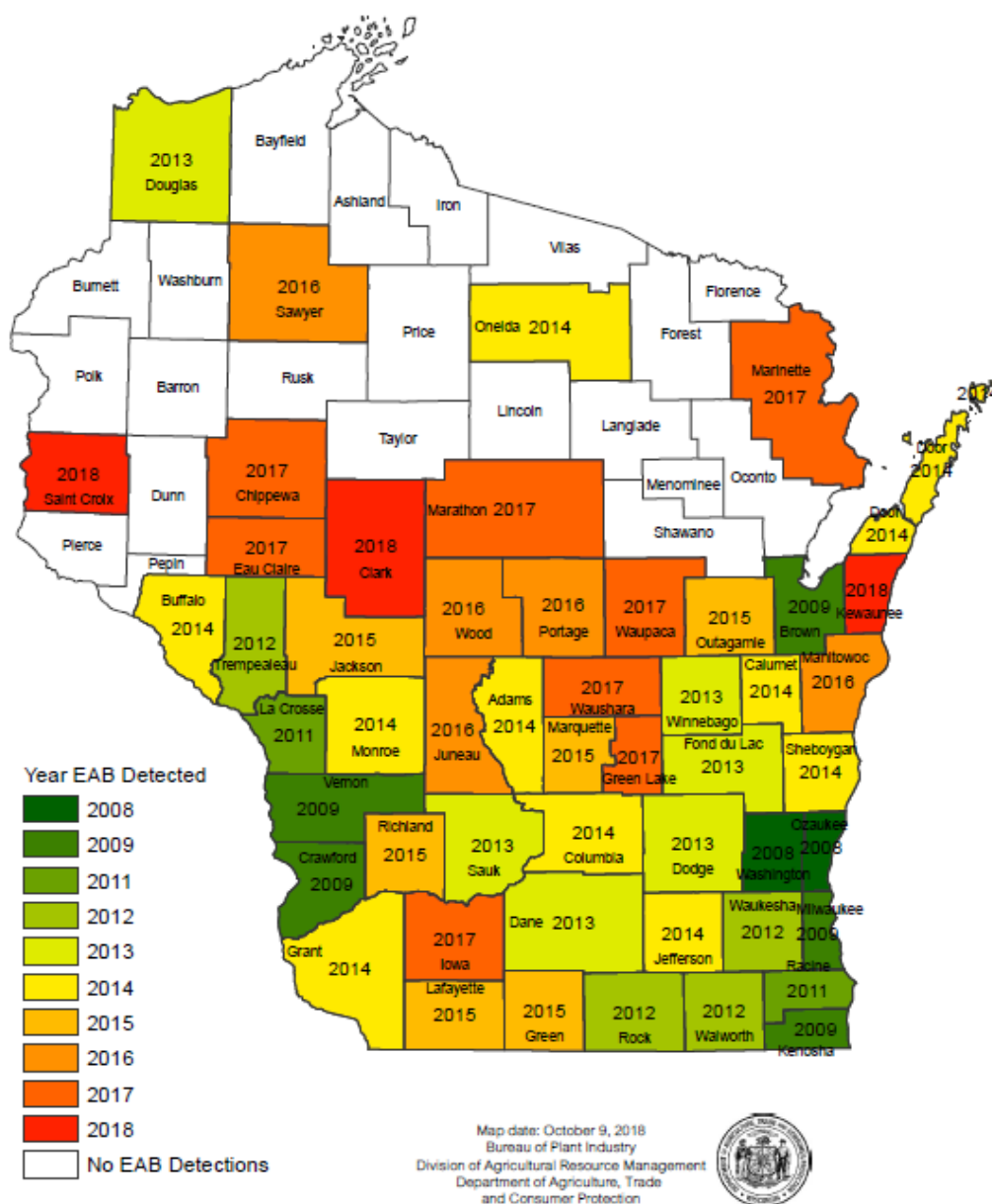


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Emerald ash borer (EAB, *Agrilus planipennis*)

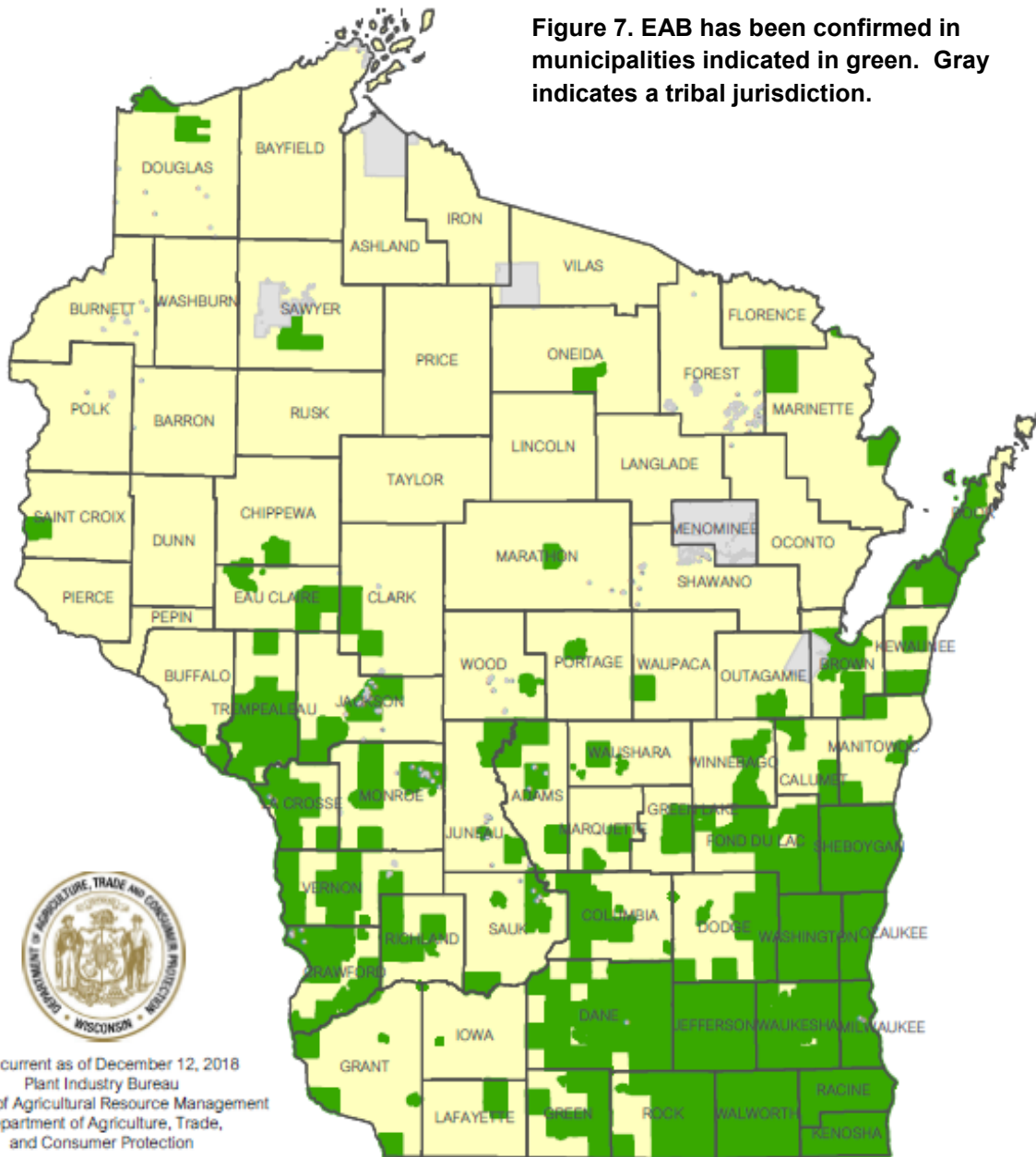
Distribution of EAB in Wisconsin

Figure 6. First detections of EAB in Wisconsin counties 2008-2018.



EAB was confirmed in three additional counties in 2018: Kewaunee, Clark and Saint Croix (Figure 6). State agencies continue to record subsequent finds at the municipal level (Figure 7). Subsequent confirmations are made from samples sent in by arborists, community foresters and the public and are identified by DNR or University of Wisconsin Extension staff. For a historical review of the spread of EAB in Wisconsin since its initial identification in 2008, see the report on

this species in the [Wisconsin DNR Forest Health 2016 Annual Report](#). There was no trapping for EAB by federal or state agencies in the summer of 2018, though some counties trapped for EAB on their county forest land for use in planning harvests. In April 2018, the quarantine on EAB was expanded statewide.



Damage from EAB in Wisconsin

In 2018, ash mortality from EAB expanded to join the two centers of mortality recorded in 2016 and 2017 to make a contiguous area of ash mortality in southeastern Wisconsin from Ozaukee

to the border with Illinois (Figure 8). Acreage where mortality predominated is estimated at 50,983 acres. Decline of ash due to EAB also expanded in the south central counties of the state around the Madison metropolitan area and bordering areas of mortality on the eastern and western sides of the state. Ash decline predominated on approximately 32,224 acres.

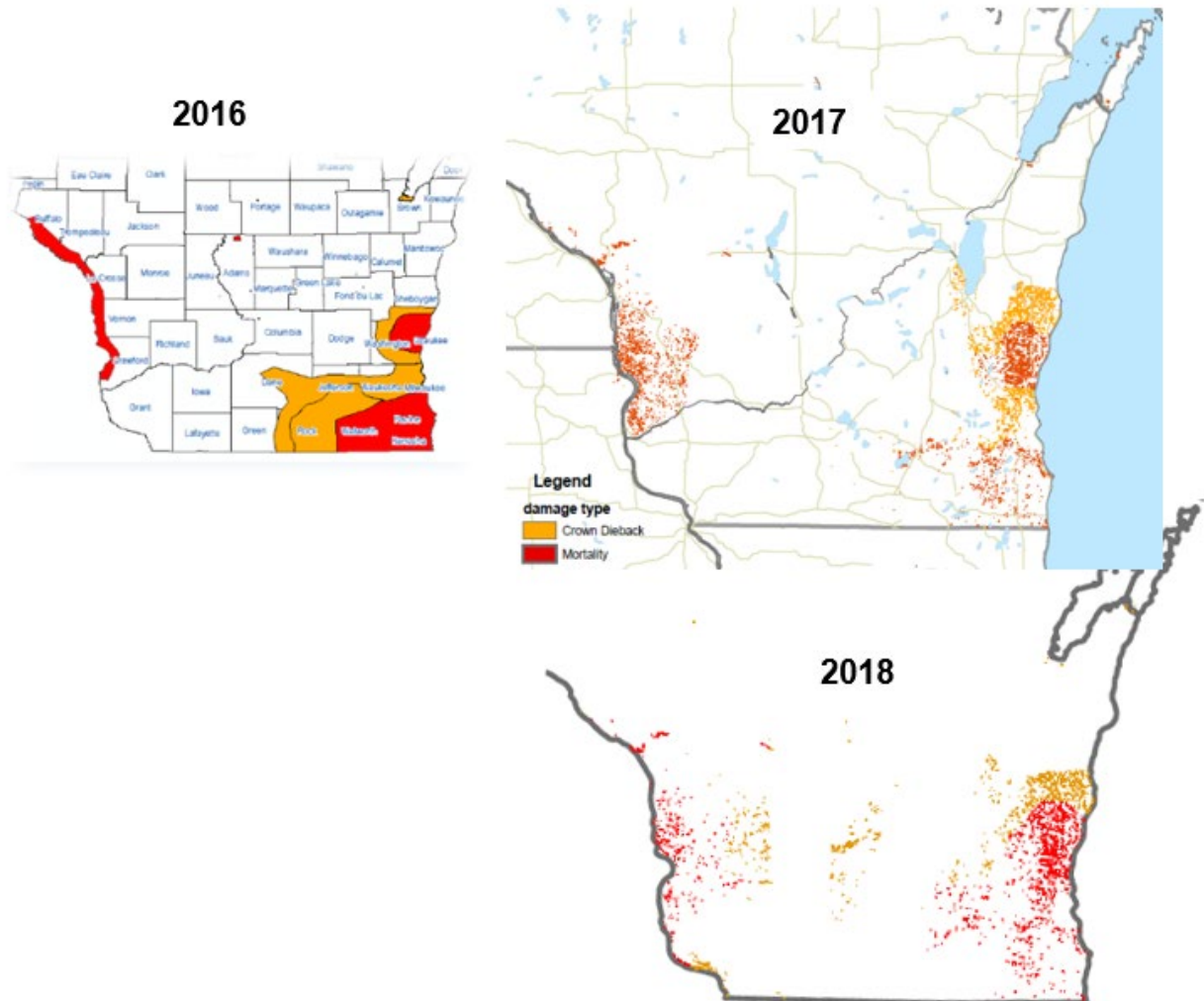


Figure 8. Areas where ash mortality was predominant are indicated in red; areas where ash decline was predominant are indicated in yellow. The maps for 2017 and 2018 appear stippled as the areas of damage were overlaid on the distribution of ash.

Biological Control of EAB

2018 is the eighth consecutive year in which DNR staff and community cooperators released natural enemies of EAB in Wisconsin. Tiny parasitoid wasps, *Tetrastichus planipennisi*, *Spathius galinae* and *Oobius agrili*, were released at seven sites in eastern Wisconsin between mid-June and early October (Figure 9). These parasitoids were introduced for the first time in Columbia, Dane and Grant counties, bringing to 18 the total number of counties where releases have been made in Wisconsin since releases started in 2011. Parasitoids are reared by the USDA APHIS Plant Protection and Quarantine EAB Parasitoid Rearing Facility in Brighton, Michigan. The wasps are supplied to states with established populations of EAB at no cost.

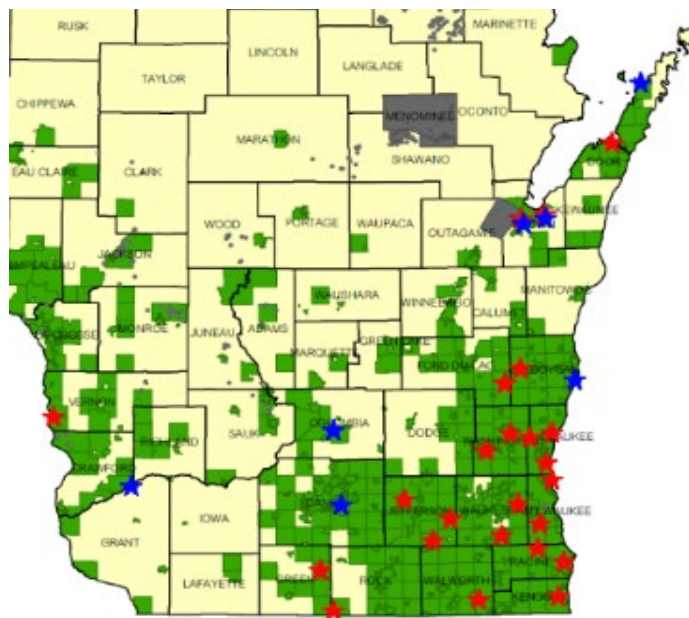


Figure 9. Release sites of natural enemies of EAB. 2018 sites are shown in blue; wasps were also released at some of these sites in 2016. Releases accomplished in previous years (2011-16) are shown in red. Communities where EAB is confirmed are shown in green.

2017 was the third year *S. galinae* was released in Wisconsin. *T. planipennisi* and *O. agrili* have been released each year since 2011. *Spathius galinae* is more cold-tolerant than the previously released *S. agrili*, which did not establish well in northern states. *Spathius* sp. have longer ovipositors than *T. planipennisi*, allowing them to attack EAB larvae beneath thicker bark than can *T. planipennisi*, avoiding direct competition between parasitoid species that both attack the larval stage of EAB. *O. agrili* attacks EAB eggs on the bark surface. These specialist parasitoids were introduced with the expectation that they will provide downward pressure on EAB populations in the future, allowing the survival of ash trees with partial resistance to EAB. These tiny wasps do not sting or bite people and, because of their small size, the public is unlikely to ever notice them.

T. planipennisi was successfully recovered at two sites in Racine and Waukesha counties where DNR staff had introduced it in 2015 (Figure 10). This is the first recovery of this species from Waukesha County, which joins Kenosha, Milwaukee, Ozaukee, Racine and Walworth and



Figure 10. Cluster of *T. planipennisi* pupae (circled) from a parasitized EAB larva, located near an unparasitized EAB larva. Photo by Bill McNee in Racine County, October 2018.

Washington counties where *T. planipennisi* was previously recovered. Voucher specimens were deposited with the Wisconsin Insect Research Collection in the UW-Madison Department of Entomology. DNR staff have surveyed for *O. agrili* by collecting ash bark from introduction sites and incubating it. If present in the bark samples, incubation will allow for the emergence of adult wasps from any EAB eggs found in the bark. To date, we have not been successful in recovering this parasitoid. Recovery surveys don't begin until two to three years after introductions, to allow released parasitoid populations to

increase to detectable levels, so we have not yet started sampling for *S. galinae*.

Gypsy moth (*Lymantria dispar*)

Gypsy moth is established in the eastern two-thirds of the state and 50 of Wisconsin's 72 counties are quarantined (Figure 11). The Slow the Spread (STS) program found reproducing but isolated populations in 13 non-quarantined counties. Those locations will be treated to reduce populations to levels where they cannot contribute to spread. A county is quarantined only when the STS program no longer treats reproducing populations detected there.

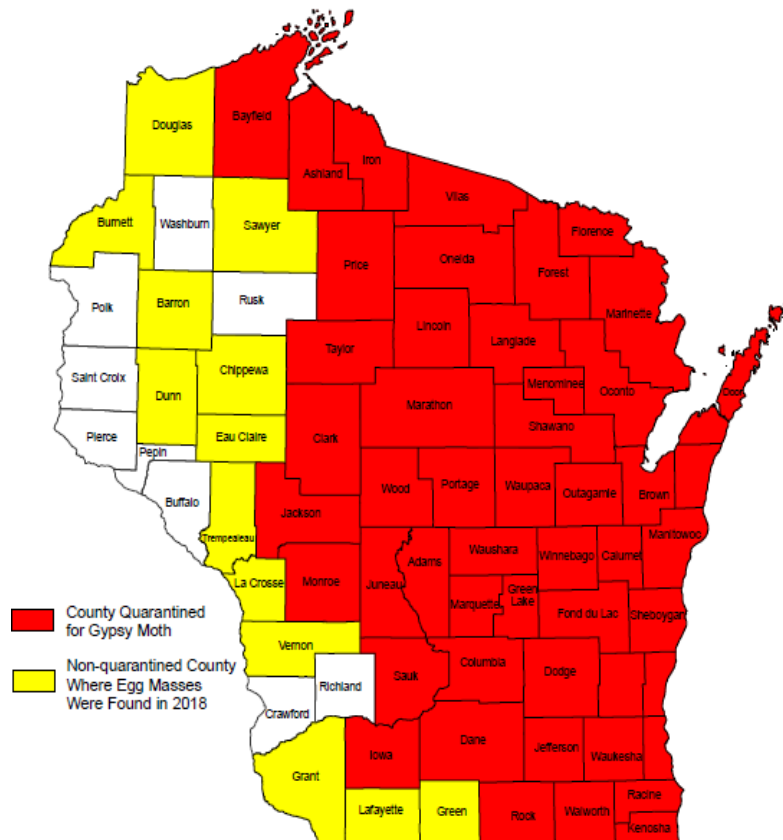


Figure 11. Wisconsin counties quarantined for gypsy moth (in red) and those outside the quarantine where egg masses were found in 2018 (in yellow).

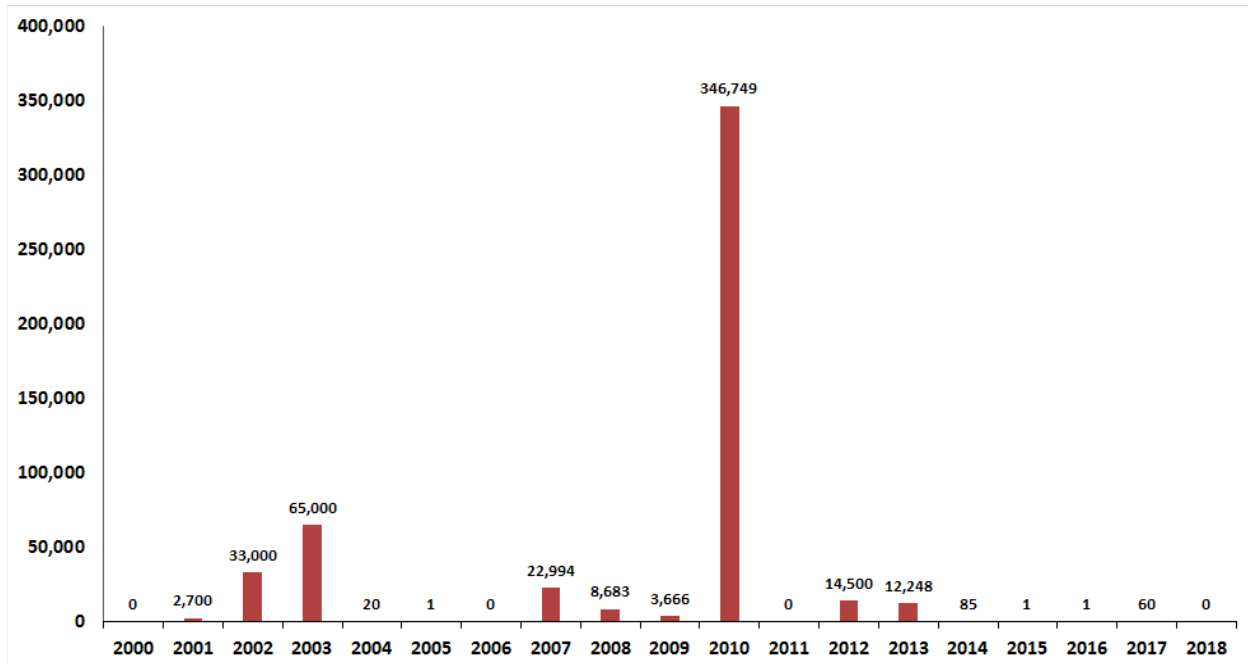


Figure 12. Acres defoliated by gypsy moth in Wisconsin 2000-2018.

Populations of the pest were low in 2018, and no damage was recorded outside of a few yard trees (Figure 12). Defoliation acres have been low since 2010 when 320,000 acres were reported as low-moderate defoliation and 25,000 acres as heavy defoliation. The preponderance of low to moderate defoliation may be due to high mortality of mid-instar larvae from the fungal disease *Entomophaga maimaiga* and Nucleopolyhedrosis virus of gypsy moth before peak defoliation could occur. Six years earlier, in 2004, the same fungus brought a premature end to an outbreak that threatened eastern counties and had encouraged communities in the area to arrange for aerial spraying on 51,450 acres. Constant rains in May allowed for an early development of the fungal epizootic, and the outbreak collapsed before caterpillars could cause much damage.

The Wisconsin Gypsy Moth Suppression Program

In May 2018, the DNR's gypsy moth suppression program aerially treated 486 acres with a bacterial insecticide containing *Bacillus thuringiensis* kurstaki. These treatments occurred at seven sites in two communities within Dane County. Foliage was successfully protected in all treatment areas. The 2018 suppression program continued the pattern seen over the last eight years of very low demand for treatment (Figure 13).

In August 2018, the Wisconsin gypsy moth suppression program was deactivated, and future applications for treatment from counties, communities, and individuals will not be serviced by the state. When the gypsy moth suppression program was developed in 2000, we anticipated that the state would eventually withdraw from offering this service as introduced natural enemies blunted outbreaks and private pest management businesses offered treatment, as has

happened in other states. In recent years, both the total acres treated, and the number of communities served have been very low. It no longer made sense to offer a statewide program for a handful of sites in one or two communities. In preparation for stepping away from suppression treatments, the DNR prepared guidance for communities and individuals wanting to control gypsy moth and other tree defoliators. This guidance includes predicting whether suppression will be needed, management options for a few trees to many acres and how to hire an arborist or aerial pesticide applicator to do the treatment. This information is available at the Wisconsin gypsy moth portal, <https://gypsymoth.wi.gov/>.

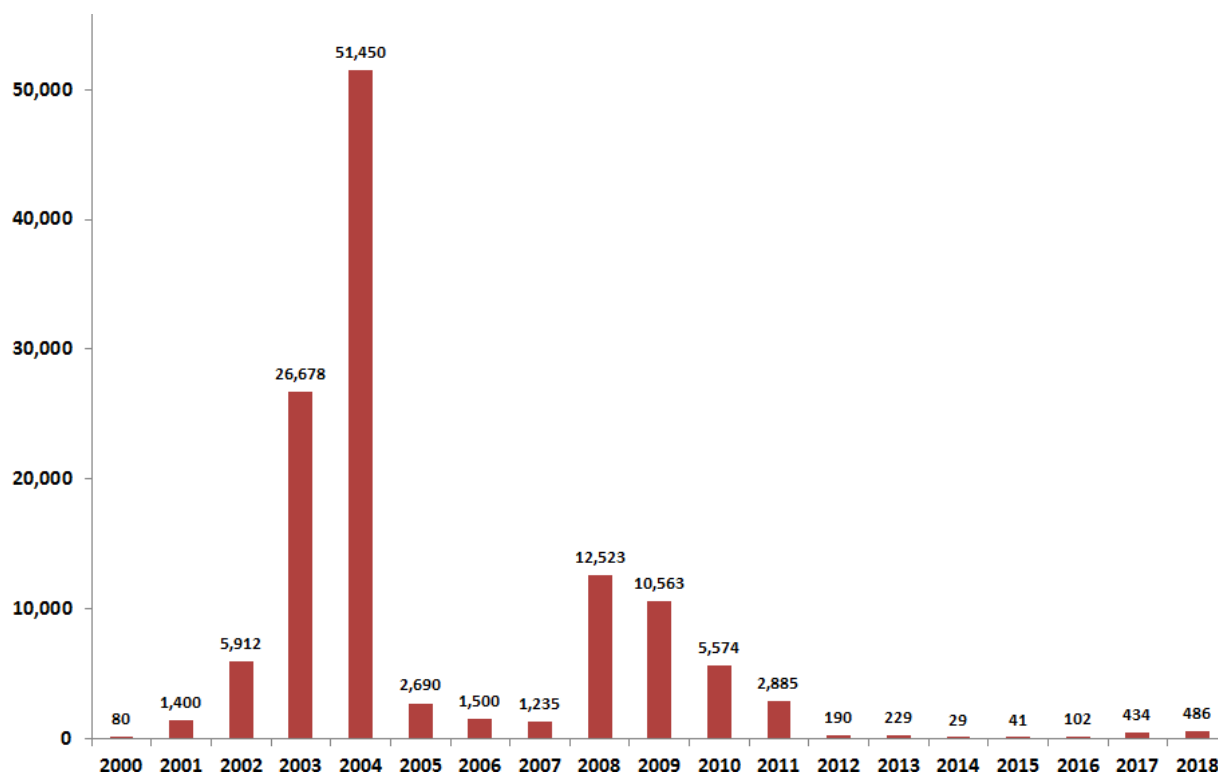


Figure 13. Acres aerially treated by the Wisconsin gypsy moth suppression program 2000-2018.

Heterobasidion root disease (HRD, *Heterobasidion irregulare*)

Heterobasidion root disease (HRD), caused by the fungus *Heterobasidion irregulare*, is one of the most destructive conifer diseases in temperate regions of the northern hemisphere. Trees with HRD exhibit thin crown, growth loss, wood decay and/or mortality. Mortality often occurs as an expanding pocket of dead trees. The pathogen is both an immediate and long-term concern because it can persist in a stand for a long time, making it difficult to regenerate the stand to desirable species.

HRD was first detected in Wisconsin in 1993 in Adams County. In 2018, it was confirmed for the first time in Monroe County bringing the total number of confirmed counties to 28 (Figure 14).

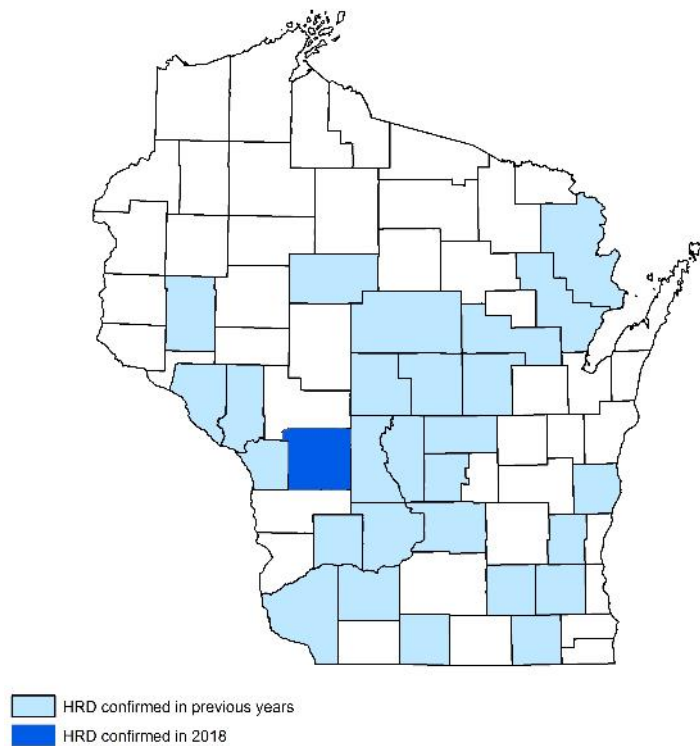


Figure 14. Distribution of HRD in Wisconsin, 2018.

Most infections in Wisconsin occur in red and white pine plantations. The new Monroe County find was in a red pine plantation in Big Creek State Fishery Area. Mortality and fruit bodies were observed on mature red pine and understory white pine saplings. The pathogen was isolated from collected wood samples and identified through microscopic examination in the Forest Health Lab.

Wisconsin requires use of preventive stump treatment guidelines on DNR-managed state lands. In 2017, a committee of stakeholders began an update of the current HRD guidelines. The committee reviewed recent research studies and surveys and evaluated the operational practicality of treatments in the field. After five face-to-face meetings, the Advisory Committee developed the final draft

revision of the guidelines. Public comments were solicited in September 2018. The revised guidelines are expected to be finalized and implemented in 2019.

Wisconsin DNR forest health staff worked with researchers at the University of Wisconsin – Stevens Point and Michigan State University to evaluate regeneration in HRD-infected red pine stands in Wisconsin and Michigan. The work was funded by an Evaluation Monitoring grant from the U.S. Forest Service. Initial results indicate that most sites will likely convert to hardwoods over time due to understory pine mortality. Final results will be available in 2019.

Invasive plant suppression program

The DNR's forest health team works to maintain and improve healthy forests by controlling invasive plants that hinder growth and regeneration. This effort includes two grant programs. The **suppression grant program** targets emerging invasive plants that have not yet become widespread. It helps landowners become compliant with the state's invasive species law which forbids possession of prohibited plants. Second, the [weed management area-private forest grant program](#) supports the formation of weed management groups that work to control the spread of invasive plants regionally and locally.

Between July 1, 2017 and June 30, 2018, the forest health team's invasive plant program used suppression grant funding as match to secure a grant from the U.S. Forest Service's

cooperative lands program to control Amur cork tree. Suppression grant funds were also used to control five additional high-priority invasive plant species (Table 1). Funding was distributed to local cooperators including private contractors, weed management groups and private landowners. Control work was conducted in eight counties and included tree felling, hand-pulling and herbicide treatments, after landowner outreach and education helped garner their permission for control work.

Table 1. High priority invasive plants controlled in 2018 by the invasive plant program.

Common name	Scientific name	Classification*	Counties where control action was performed
Amur cork tree	<i>Phellodendron amurense</i>	Prohibited	Adams, Dunn
Policeman's helmet	<i>Impatiens glandulifera</i>	Prohibited	Dane
Princess tree	<i>Paulownia tomentosa</i>	Prohibited	Iowa
Wild chervil	<i>Anthriscus sylvestris</i>	Split-listed	Chippewa, Columbia, Dunn,
Tree-of-heaven	<i>Ailanthus altissima</i>	Restricted	Sauk
Yellow archangel	<i>Lamium galeobdolon</i>	Early detection	St. Croix

**Prohibited* refers to species that are infrequent or absent in Wisconsin and may not be possessed by a landowner. *Restricted species* are more widespread and may be possessed. *Split-listed species* are prohibited in some counties and restricted in others. *Early detection species* are those plants known to be invasive elsewhere but are not yet listed under [NR 40](#), the state's invasive species rule.

Amur cork tree (*Phellodendron amurense*)

The invasive Amur cork tree (ACT) is aggressively moving into forests in other Midwestern states and it is currently found in a dozen Wisconsin counties with county populations ranging from single trees to several thousand. In 2018, control work continued in two hotspot counties (Adams and Dunn) and began in a third hot spot county (Columbia). Inventory and preparations for control began in the remaining counties. Fruiting trees are believed to have been eliminated from three counties already (Dane, Portage, Waukesha).

Adams County

Control work in Adams County was conducted on eight private properties (Table 2) with over 2000 trees being eliminated from 150 acres.

Table 2. Results of control work in Adams County.

Property owner	Parcel acreage	Season	Treatment method	Number of treated tress	Outcome
Roberts	29	Fall 2017	Cut stump	~1000	No spring regrowth
Roberts	37	Fall 2017	Cut stump	Several hundred	No spring regrowth
Roberts	40	Fall 2017	Cut stump	Several hundred	No spring regrowth
Roberts	10	Fall 2017	Cut stump	Not reported	Not reported
Cooper	10	Fall 2017	Cut stump	500	No spring regrowth
Sullivan	6	Fall 2017	Cut stump	Not reported	Not reported
Rutkowski	9	Fall 2017	Cut stump	Not reported	Not reported
Roberts	9	Winter 2018	Basal bark	Several hundred	Some spring leaf out on treated trees but much less than on untreated trees
Total	150			>2100	

Columbia County

Outreach

DNR staff sent letters to landowners surrounding the DNR-owned MacKenzie Center, which is the epicenter of the Columbia County infestation, to alert them that ACT might occur on their property. The letters also communicated the availability of assistance for control and requested that they report whether the tree is found on their property. To date, one landowner has responded to say that ACT is not found on their property. DNR staff at MacKenzie Center reported that the species had spread to a contiguous property whose landowner did not respond to the letter. DNR staff reported ACT from two other DNR properties nearby.

Control work

A grant to a contractor was used to cut and stump-treat five ACT at the MacKenzie Center growing in and around buildings, animal enclosures and public trails and required careful felling. A second grant was issued to the MacKenzie Center to purchase equipment and herbicide that staff used to control ACT in other parts of the property. In November and December 2018, DNR staff cut and treated approximately 200+ trees on 6.25 acres. Volunteers from Friends of MacKenzie assisted staff with clearing slash resulting from the control work.

Dunn County

In the past two years, the Lower Chippewa Invasives Partnership (LCIP) has done extensive outreach to landowners in Dunn County, having sent some 1000 letters to landowners. Based on reports from these letters, LCIP has used a DNR grant to assist landowners with ACT control. LCIP has controlled ACT on at least nine properties.

Additional discoveries of ACT

Grant County

In the past few months, ACT was found spreading into forest land from a fruiting tree planted on the landowner's property. The extent of the infestation remains to be determined.

La Crosse County

DNR received a report of a fruiting ACT on one Onalaska property that has spread to several neighboring properties.

Waupaca County

There is one report of ACT in a residential setting in this northeastern county pending further investigation.

Lesser celandine (*Ranunculus ficaria*)

Control of lesser celandine is complex and difficult. This ephemeral plant appears in April, flowers (Figure 15), forms vegetative reproductive growths, and then dies back by early June. Since the plant is only visible for a short time, it is difficult to take new finds from discovery to treatment before the plant goes dormant underground, where it cannot be treated. Consequently, the forest health team staged its efforts by treating previously known populations for which they had pre-arranged landowner permissions. When new detections are made, DNR forest health staff and local cooperators contact landowners and provide information on plant identification and control methods. Those landowners are encouraged to plan control actions the following spring.



Figure 15. Lesser celandine by Robert Bierman.

Since 2015, Forest Health staff have worked to control lesser celandine in other portions of southeastern Wisconsin, including Milwaukee, Kenosha and Racine counties. Federal funding from the Great Lakes Restoration Initiative was secured by DNR's Lakes and River section for lesser celandine and other facultative wetland plants, such as giant hogweed and hairy willow herb. Lakes and Rivers worked with the network of cooperators that Forest Health brought together in their previous work on these species. This funding allowed for control work to continue in 2018 on lesser celandine, giant hogweed and hairy willow herb.

Walworth County

What started with a small number of known occurrences and some old records led to the discovery of the state's largest infestation of lesser celandine in Walworth County. This infestation includes over 80 properties in the Lake Geneva area.

Forest Health staff developed a network of local cooperators to assist with this project, including the Geneva Lake Conservancy, Walworth County Land Use and Resource Management department and local landscapers. Outreach

efforts included letters and informational flyers to landowners in the known infested area, presentations to landscapers and media press releases. The resulting flood of reports showed that the plant was more widespread than first known and that landowners are willing to control the plant. Some landowners started control work without any financial assistance in 2018.

Seeing the size of the infestation, DNR secured a grant from the U. S. Forest Service that will aid landowners in Walworth County in controlling the plant on their land in fiscal year 2019.

Lesser celandine often grows in wet forests in riparian zones along rivers and lakes. These lands, often private and otherwise hard to access, have not been thoroughly surveyed for lesser celandine. An experimental aerial survey was conducted on May 5, 2018 to see if lesser celandine could be seen from an airplane. Since the large mats of lesser celandine green up and flower before the forest canopy has full leaf cover, we flew over Walworth County to see if the plant could be seen from the air. Local cooperators provided valuable information on the plant's phenology that helped pick a good time to fly.

We found that lesser celandine showed up as large swathes of bright lime green vegetation on the forest floor and could be distinguished from other early growers with yellow flowers, such as dandelion and marsh marigold (see Figure 16) . With that confirmation, we then surveyed five river systems in southeastern Wisconsin. In three hours of flight time we covered 77.8 miles of river corridors and found no new lesser celandine populations. Trying to survey the rivers on the ground or by watercraft would have taken more than a week of work.



Figure 16. Lesser celandine as seen during aerial survey on May 5, 2018. Bright lime green ground cover to the right of the road is lesser celandine.

Tree-of-heaven (*Ailanthus altissima*)

Tree-of-heaven is relatively common in urban settings in southeastern Wisconsin. However, in 2017, a small population was found for the first time in rural Sauk County (Figure 17). This was of special concern due to the trees' location at the headwaters of the [Wisconsin River State Riverway](#). The riverway is biologically important with extensive floodplain and upland forests throughout its nearly 50,000-acre area. It hosts 147 state species that are endangered, threatened or of special concern.



Figure 17. This seed-producing tree-of-heaven in Sauk County was destroyed in 2017. Photo by Mike Putnam.

Preparations in 2017 included contacting landowners and local cooperators. This was followed by control efforts in 2018. Two local governments voluntarily controlled tree-of-heaven on their properties, at no cost to DNR. Sauk County highway department felled tree-of-heaven while constructing the Great Sauk State Trail, a rails-to-trails project, while the village of Prairie du Sac removed it from a park through which the trail project passes. Funding from the suppression grant program was used to hire a private contractor that controlled the tree on three private properties along the trail and at a village campground and boat launch.

Oak Wilt (*Bretziella fagacearum*)

Oak wilt disease is caused by the pathogenic fungus *Bretziella fagacearum* (previously known as *Ceratocystis fagacearum*). Lethal to northern pin, northern red and black oaks, the disease is widespread in the southern two-thirds of the state, although it is still uncommon in northern Wisconsin. However, DNR forest health staff continue to find isolated disease centers in northern Wisconsin each year.

In 2018, oak wilt disease was detected in Bayfield and Douglas Counties for the first time in several townships (Figure 18). Oak wilt has now been confirmed in 64 of Wisconsin's 72 counties. Wood samples from

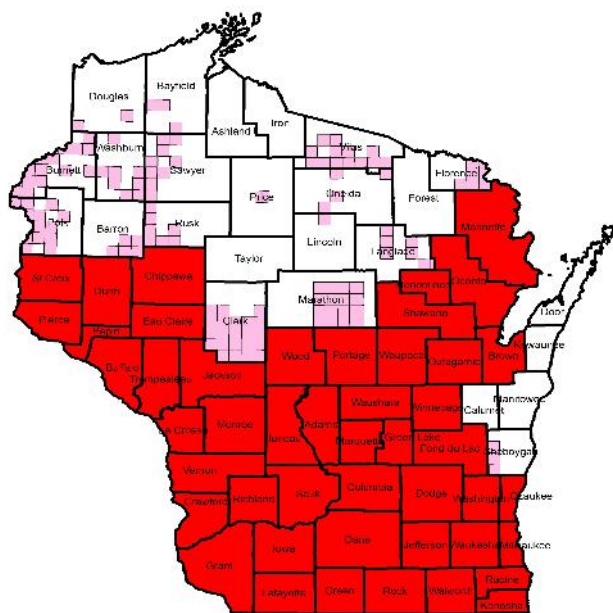


Figure 18. Oak wilt is generally established in counties tinted red. It has been confirmed in townships tinted pink in otherwise non-infested counties.

suspect red oaks on private, county forest and U.S. Forest Service property tested positive for the fungal pathogen. Identification of the fungus was done through DNA testing at the DNR Forest Health Lab and DNA sequencing at the University of Wisconsin–Madison’s Biotechnology Center.

In 2018, oak wilt was detected for the first time in the following northern townships: Barnes, Cable, Drummond (Bayfield Co.); Dairyland, Gordon (Douglas County); Elcho, Neva (Langlade Co.); Couderay Hayward, Hunter, Round Lake, Spider Lake, (Sawyer Co.); Lac du Flambeau, St. Germain (Vilas Co.). In 2017 it was detected for the first time in these townships: Mitchell (Sheboygan Co.), Langlade (Langlade Co.); Boulder Junction, Cloverland, and Plum Lake (Vilas Co.); Stone Lake (Washburn Co.).

White pine bast scale (*Matsucoccus macrocitrices*)

White pine bast scale and the canker fungus, *Caliciopsis spp.*, was identified in Wisconsin at several sites in Oneida, Marinette and Vilas Counties.

White pine bast scale, a native scale, is tiny, black, oval-shaped and lacks both eyes and legs. It uses a long stylet to siphon sap from outer layers of phloem (bast) of twigs and branches. White pine bast scales often live under lichens on white pine branches (Figure 19). Although lichens don’t directly harm trees, they provide shelter for scale insects.

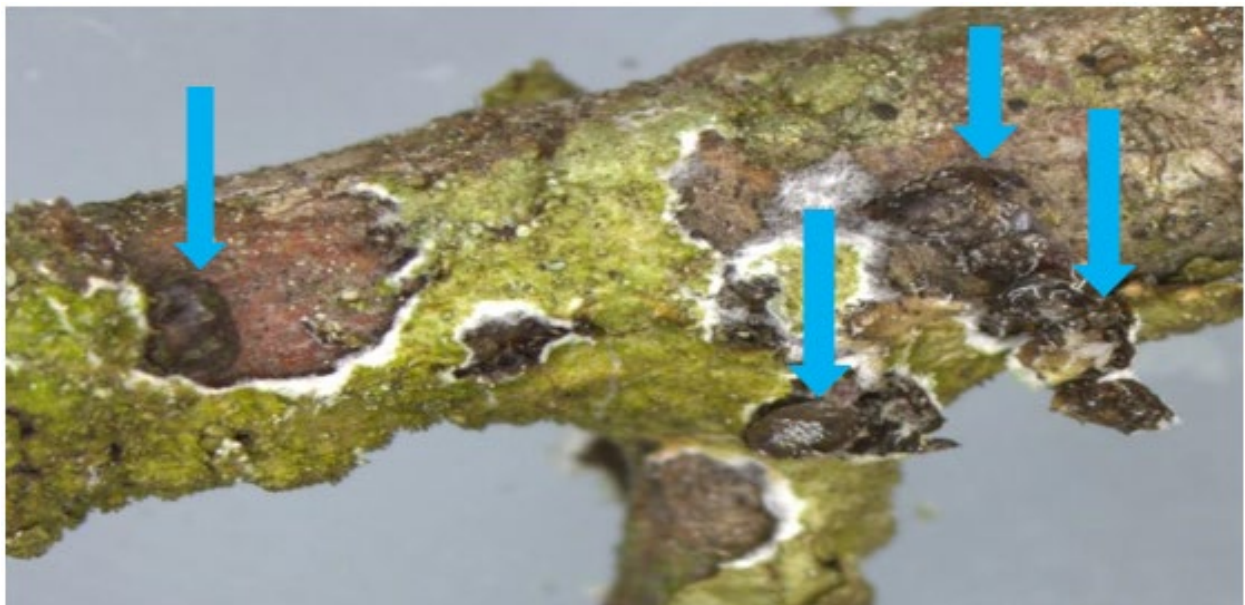


Figure 19. Removing portions of this green-colored lichen from a white pine branch reveals several dark brown oval bast scales (blue arrows).

The fungal pathogen, *Caliciopsis spp.*, causes small cankers, or dead spots, on branches (Figure 20). It can infect the branch through the tiny feeding wounds of the bast scale. Many cankers can develop on each branch. As more cankers develop, affected branches begin to die.

Branch mortality due to the combination of white pine bast scale and the *Caliciopsis spp.* typically begins on lower branches but was generally noted in the lower $\frac{3}{4}$ of the crown of affected trees. White pine bast scale by itself has not previously been known to cause problems in white pine. White pine blister rust (*Cronartium ribicola*) can kill branches as well and can look like the symptoms of bast scale and *Caliciopsis* canker.



Figure 20. Brown staining under the bark caused by *Caliciopsis* canker.

Hardwood issues

Bur oak blight (*Tubakia iowensis*)

Bur oak blight (BOB) was initially found in Wisconsin in 2010 and has been confirmed in 27 counties (Figure 21). BOB continues to be recorded in urban and forested areas in counties where the disease was previously found, but no new counties were added in 2018.

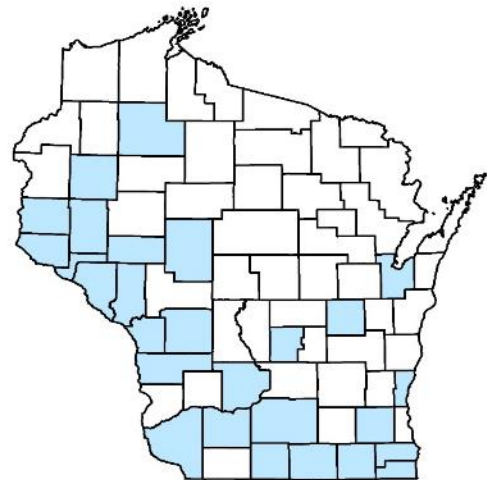


Figure 21. Bur oak blight has been confirmed in counties highlighted in blue.

Bur and White Oak Dieback

Bur and white oaks were impacted by a variety of insect and disease issues in 2018. Early in the year widespread dieback of bur oak twigs and branches and delayed leaf-out were noted in northwest Wisconsin. Crown dieback of 10-50% was observed in both mature and sapling-sized trees although the damage was most common on open-grown trees and those along woodland edges. Cynipid gall wasps and *Botryosphaeria* fungal infection were the main causes of the dieback. By early July most trees recovered from the damage.

Later in the summer, damage started to appear in southern and central Wisconsin on both bur and white oaks. Leaf fungal pathogens and *Botryosphaeria* caused most of the symptoms, but

small numbers of gall wasps were noted at some sites. Leaves on affected trees turned brown, curled and died prematurely (Figure 22). Impacts varied widely from tree to tree (less than 25% of leaves affected to more than 75%), even within the same stand. The wet, humid summer likely created ideal conditions for the fungal pathogens. Similar to the bur oak impacts early in 2018, we expect bur and white oaks impacted late in 2018 to recover by early summer of 2019.



Figure 22. Bur oak infected with *Botryosphaeria* and fungal leaf infections in south central Wisconsin. Photo by Mike Hillstrom.

Phytoplasma (*Candidatus* Phytoplasma fraxini)

Phytoplasmas are small bacteria that lack cell walls. They live as obligate parasites and plant pathogens. In trees, they cause small and yellowed foliage, slow growth, thin crowns, branch dieback and vertical bark cracks. Due to characteristic foliage chlorosis, phytoplasma is commonly called “yellows disease”. Infected trees and stumps may produce clusters of spindly shoots that are known as “brooms”.

Ash yellows was first found in Wisconsin on white ash in 1987. Currently, phytoplasma has been confirmed in 32 counties in Wisconsin and in 15 tree species using the genetic testing method of polymerase chain reaction which does not distinguish between different subgroups of phytoplasma (Figure 23). To determine if different hosts have *Candidatus* Phytoplasma fraxini,

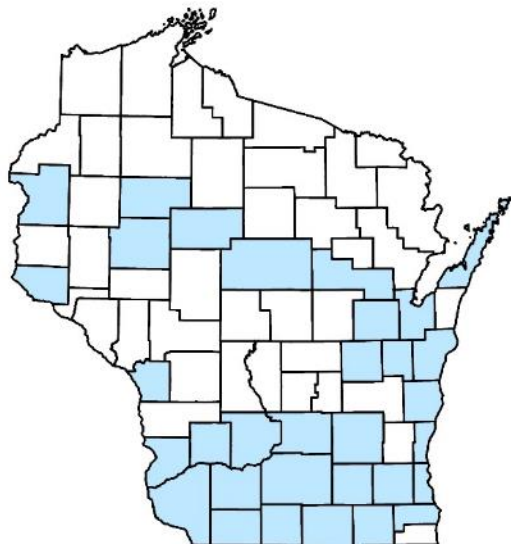


Figure 23. Counties in Wisconsin where phytoplasma has been confirmed are tinted blue.

the ash yellows phytoplasma, or a different group/subgroup of phytoplasma, DNR staff collected samples from trees that had tested positive for the disease in previous years. University of Wisconsin Plant Disease Diagnostics Clinic staff sequenced amplified DNA products extracted from samples and compared them with records from the National Center for Biotechnology Information. Initial results found sequences of amplified DNA products extracted from white ash were consistent with those previously reported for *Candidatus* Phytoplasma fraxini, the ash yellows phytoplasma. Results from samples from other host species are thus far inconclusive, but additional analyses of these samples are in progress. Results for other host species are expected in 2019.

Aspen blotch miner (*Phyllonorycter apparella*)



Figure 24. Brown blotches on the underside of an aspen leaf, showing damage from multiple aspen blotch miner larvae.

Aspen blotch miner caterpillars spend their entire life feeding within aspen leaves. They mine out an area of the leaf, leaving both top and bottom layers of the leaf. This creates translucent areas of the leaf that will eventually turn brown and can cause the leaves to shrivel when multiple blotch miners are present on a leaf (Figure 24). Typically, these leaf-mining insects only affect young aspen trees, but this year uniform damage on larger trees was noted. Symptoms include thin crowns, off-color leaves with blisters on their undersides and, later in the summer, curling and browning leaves.

Damage in Wisconsin has been noted each year since 2012. This year, significant defoliation was observed in Florence, Forest, Marinette, Oneida and Vilas counties, which is similar to where they were found in 2017. Defoliation was also observed in one stand in Ashland County.

Although defoliation can be severe, aspen trees usually tolerate the situation well. Many affected aspen trees will send out new leaves after feeding by the caterpillars ends. Although damage may appear severe, the effects on the trees' overall health seems negligible.

Conifer Issues

Balsam fir mortality in May due to winter and spring weather

Reports of balsam fir suddenly turning rusty red to brown and dying began in mid-May across the northern half of Wisconsin due to winter and spring weather patterns. Rapid mortality of balsam fir was also reported in many central and west central Wisconsin counties at the same time.



Figure 25. Variation in mortality of balsam fir in a natural stand.

Symptoms were the same on all affected trees, regardless of location, and included:

- The top $\frac{1}{2}$ – $\frac{3}{4}$ of the tree died quickly, often followed by the bottom a few weeks to a few months later;
- All sizes of trees were affected from seedling/saplings, up to large trees;
- Open grown, understory, plantation, yard trees, forest trees, Christmas trees (per DATCP) were all impacted with 20-60% of balsam trees impacted at any one site;
- Often affected trees were growing next to other trees that appeared healthy (Figure 25).

There were no diseases (cankers, root disease, etc.) found on the dead and partially dead trees. The area between dead top and green branches on the bottom was not defined by a canker margin. The top was dry and dead.

Bleeding spots on the main stem indicate attack by bark beetles although bark beetles were clearly secondary pests on these trees. No other insects or diseases were found on the affected trees.

As the season progressed, balsam trees with the top $\frac{1}{2}$ - $\frac{3}{4}$ dead, were observed to have armillaria root disease beginning to kill the remainder of the tree (Figure 26).

The primary cause of mortality was determined to be weather related, but not your typical winter desiccation. The winter of 2017-18 in northern Wisconsin was prolonged with a number of warm sunny days throughout the winter and winter weather continuing until the end of April. Very low relative humidity levels in late April, with sunny days, caused needles to begin to dry out. Following a couple late-April snow storms, the snow began to melt and the frost to leave the ground, but the transition between winter weather (late-April 2018 saw significant snow events) and very warm spring weather in early May, was abrupt (Figure 27). Temperatures that soared into the 70's and 80's in early May caused trees to begin photosynthesizing, although they had no way to replenish lost water since roots were still frozen or under snow. Statewide the temperatures didn't seem



Figure 26. White mycelial fans of armillaria root rot in the lower trunk of a top-killed balsam fir.



exceptional but looking more closely at the end of April in northern Wisconsin, you can see the daytime highs were above average and the nighttime lows were below average (Figure 28). All of these factors worked together to be too much stress for some balsam, which caused the rapid mortality that was observed.

Figure 27. This photo was taken in Vilas County on April 24, 2018, showing a significant amount of snow remaining on the ground. Just days later the temperatures were in the upper 70's in this area.

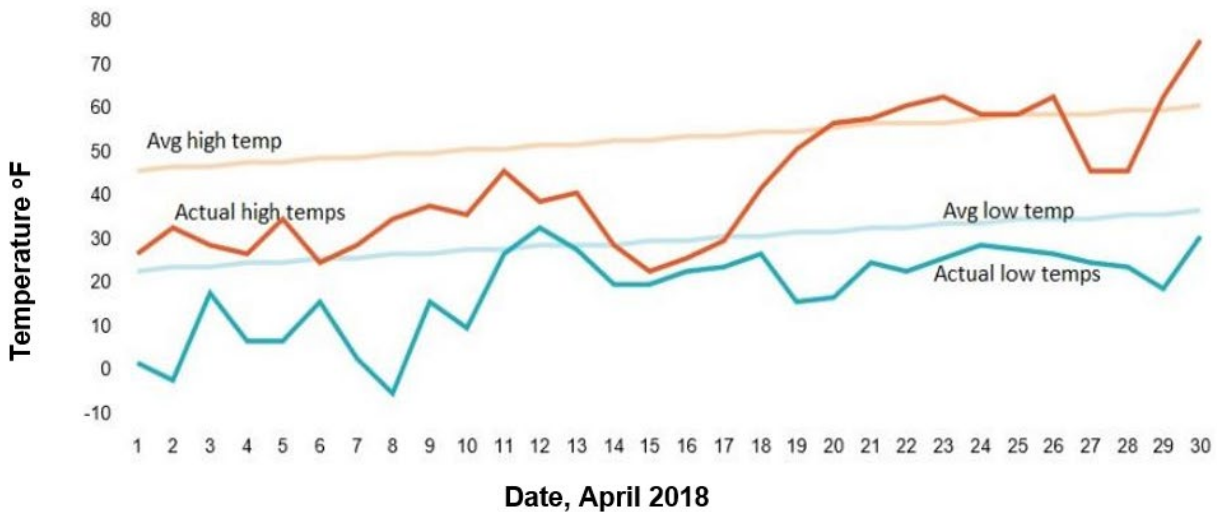


Figure 28. Temperature data from Eagle River, WI weather station for April 2018. The combination of nighttime freezing and daytime thaws can cause needles to lose water and suffer freeze damage. Graphic from AccuWeather.com.

Eastern larch beetle (*Dendroctonus simplex*)

Eastern larch beetle is a native bark beetle that attacks tamarack by tunneling under the bark, girdling and eventually killing the tree (Figure 29). Scattered damage and mortality from eastern larch beetle was first noticed in the state in 1999, and annual mapping efforts have continued each year since 2012. In 2018, 616 acres with scattered tamarack were killed in Florence, Forest, Marinette, Rusk, Sawyer, Vilas and Washburn Counties. Like other bark beetles, eastern larch beetle first attacks stressed trees, but as beetle populations build in a stand, a localized outbreak may occur and lead to death of most trees in a stand, even without additional stress-causing events. Inciting stressors may have included drought in 2012-13, larch casebearer defoliation in 2014, record rainfall throughout the growing season that flooded stands for extended periods in 2017, and above-average temperatures over several decades. This combination of factors has created more favorable conditions for beetle overwintering survival and life-cycle development.



Figure 29. Woodpeckers strip bark off tamarack infested by eastern larch beetle, giving the trees a reddish appearance. Photo by Linda Williams.

State nursery studies

Asymptomatic infection by *Diplodia sapinea* in state nursery stock

Asymptomatic infection by *Diplodia sapinea* in red pine seedlings can result in failure of the plantation if the disease becomes symptomatic after planting. To prevent this, healthy-looking red pine seedlings from the Wilson State Nursery have been tested annually to assess for asymptomatic infection prior to sale. Asymptomatic infection rate must be 10% or less or the stock will not be sold. In 2018, despite wet summer weather that was ideal for the development of the pathogen in the nursery beds, the nursery's fungicide regimen kept infection rates well below the 10% threshold. The infection rate for 2-year old seedlings (382 seedlings tested) was 3.1% and 3-year old seedlings (160 seedlings tested) was 1.9%.

Survey of galls on jack pine seedlings at the Wilson Nursery

Historically, gall incidence caused by gall-forming rust fungi on jack pine seedlings is very low at the Wilson State Nursery. Surveys conducted in 2009-2012 found a 0%-0.5% incidence rate on one-year old jack pine seedlings. However, slightly increased gall incidence was noted when seedlings were lifted from nursery beds prior to packing and sale in 2016 and in 2017. 1,000 one-year-old jack pine seedlings were randomly selected and thoroughly examined in the lab for the presence of galls. The incidence rate was 2.9%, an increase from historical levels and a concerning development. In response, Wilson Nursery implemented fungicide applications to

control this problem during the 2017-18 growing seasons. In 2018, 1,000 1-year old and 1,000 2-year old jack pine seedlings were randomly selected at the time of spring lifting and each seedling was thoroughly examined for the presence of galls. None were found in the visual inspection, indicating that the fungicide treatment was successful in controlling the gall-forming rust fungi.

Rhizosphaera on spruce

Rhizosphaera needle cast heavily impacted many spruce trees and plantations across Wisconsin in 2018. Like many fungal diseases, Rhizosphaera benefits from wet conditions and 2017 and 2018 were much wetter than normal. January through July 2017 was the wettest period in the 123 years that data has been collected in Wisconsin. Rainfall in 2018 continued to encourage needle infection throughout the growing season. Some spruce plantations, as well as many yard trees, were heavily impacted with only the upper ¼ - 1/3 of the tree having any needles remaining (Figure 30).



Figure 30. A white spruce plantation showing significant needle mortality due to Rhizosphaera needle cast.

Spruce budworm (*Choristoneura fumiferana*)

Defoliation of spruce and balsam fir due to spruce budworm in 2018 was less than observed 2017, which was less than was observed in 2016. Areas of Ashland, Bayfield, Florence, Marinette, Shawano, Oconto and Vilas Counties had patchy light or moderate defoliation, with a few localized areas of severe defoliation in Shawano and Oconto counties, similar to what



Figure 31. Spruce budworm larvae and feeding damage.

occurred in 2017. Growth rates on trees were generally good, which gave a greener look to the forest even though spruce budworm was still causing defoliation (Figure 31).

Regional budworm outbreaks occur every 30-50 years and can last 10-15 years. Wisconsin's last outbreak ran from 1970 to 1980. Mature balsam fir and spruce are the

primary targets, although younger balsam or spruce can be defoliated as well. Repeated defoliation can cause top-kill and eventually whole tree mortality.

Abiotic Issues

Temperatures were slightly below average early in 2018 but April was one of the coldest on record in Wisconsin. Temperatures averaged 8 to 11 degrees below normal (Figure 32). Snowfall was also unusually heavy for April with many locations in north central and northeastern breaking previous records for that month: Shawano, Oconto, Peshtigo and Sturgeon Bay all had snowfalls over 40 inches in April 2018 compared with previous records where snowfall was in the teens. The start of the growing season was delayed compared to recent years, but well above average temperatures in May resulted in rapid degree day accumulation and a very quick transition to tree leaf out. Temperatures remained above average through the summer and fall.

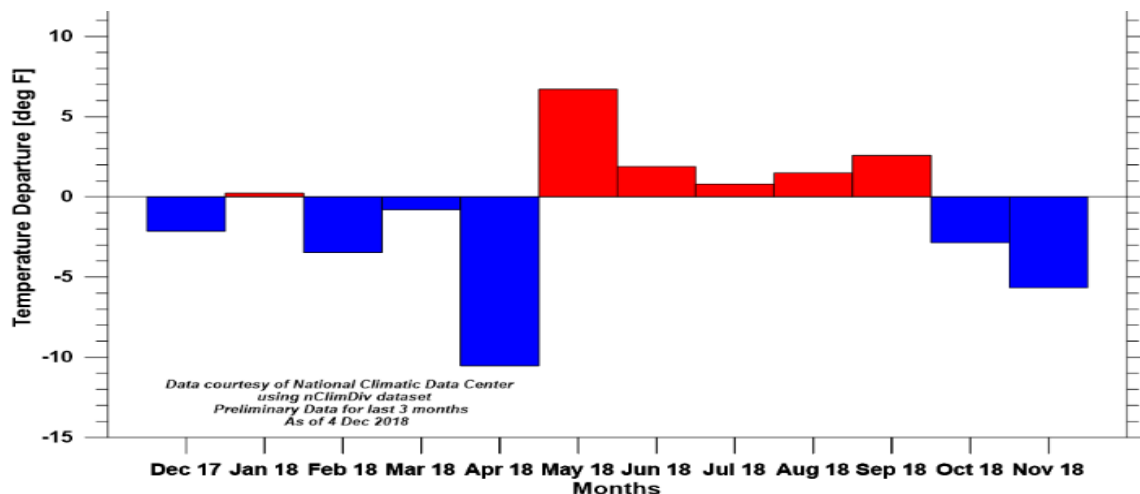


Figure 32. Wisconsin statewide monthly temperature departures from 1981-2010 normals, Dec 2017-Nov 2018.

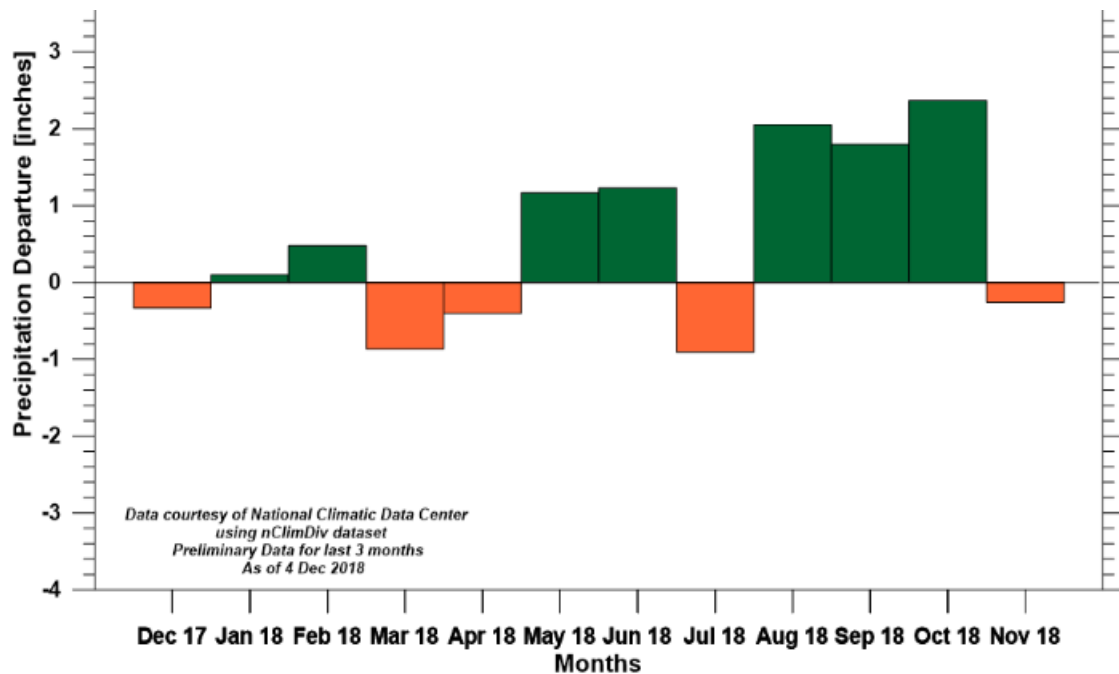


Figure 33. Wisconsin statewide monthly precipitation departures from 1981-2010 normals, Dec 2017-Nov 2018.

Precipitation was above average most of the summer across Wisconsin (Figure 34). Several extreme rain events in southern Wisconsin in August dropped 8-12 inches of rain in a 24-hour period. These events caused major flooding that continues to impact land near lakes and rivers. Storms throughout the summer were fed by high humidity which also set the stage for several of the forest health issues discussed in this document such as *Rhizosphaera* needlecast on spruce and *Botryosphaeria* and leaf pathogens on oaks.

Above average precipitation in the last few years is causing dieback and mortality of trees around lakes and in seasonally wet areas that have been consistently flooded during the growing season in many parts of the state (Figure 34). We expect to see more damage in the next few years caused by flooding in 2018. Site visits and aerial surveys conducted in eastern Wisconsin during July and August found that multi-species decline and mortality were common. Extended inundation during the growing season inhibits root aeration, and even tree species that are tolerant of seasonal inundation, such as silver maple, were declining and dying. Many locations where flooding and premature color change were reported in 2017 had heavy mortality in 2018.



Figure 34. Flooding-induced mortality in Kewaunee County, July 2018. Bill McNee.

Premature color change was observed on stressed trees at some flooded sites as early as mid-July 2018. According to the State Climatology Office, parts of east central Wisconsin received as much as 8 inches more precipitation than average in April through June of 2018.

Heavy rainfall and flooding was not the only storm damage in 2018. On August 28, severe storms produced 19 EF0 to EF2 tornadoes that damaged forests in Adams, Marquette, Green Lake, Fond du Lac and Sheboygan Counties (Figure 35). EF0 tornadoes have winds of 65-85 mph, EF1 have winds of 86-110 mph and EF2 have winds of 111-135 mph. Approximately 600 acres of concentrated storm damage was reported in Fond du Lac and Sheboygan Counties (Figure 36). Scattered damage across 2375 acres occurred in Adams, Marquette and Green Lake Counties. Foresters from the DNR and private sector quickly worked to establish timber sales and salvage many of the damaged trees.

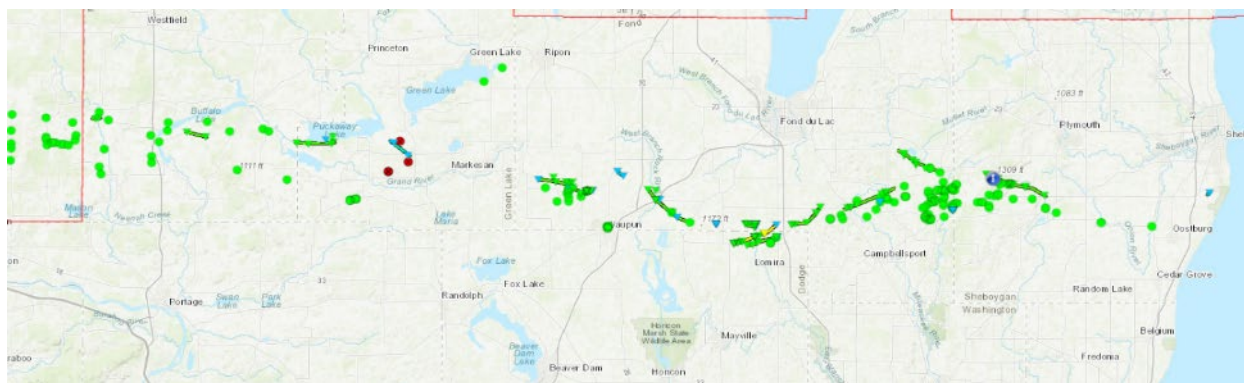


Figure 35. Tornado damage confirmed on August 28, 2018. Blue: EFO, Green: EF1, Yellow: EF2, Red: unknown. Figure by National Weather Service.

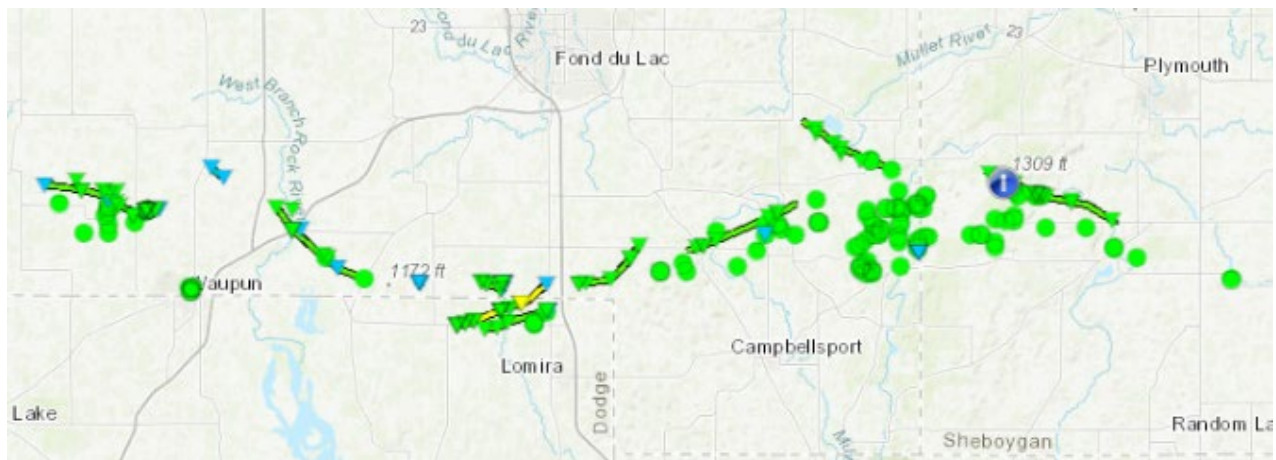


Figure 36. Detailed map of the tracks of tornados in the area of heaviest damage, August 28, 2018.

Acknowledgements

Projects and this report were funded in part through a grant awarded by the U.S. Forest Service Northeastern Area State and Private Forestry. The USDA is an equal opportunity provider and employer.